

CNES EESS Missions using X-Band Telemetry

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THE SPOT FAMILY

PLEIADES

DEMETER

SPOT : The system today

- ◆ **Operational Earth observation system**
- ◆ **Frequent revisit capability and image acquisition, currently offering 10-meter (till spot 4) and 2.5-meter (spot 5) resolution**
 - **Fast global coverage (60km x 60km)**
 - **Short turnaround times thanks to oblique viewing**
- ◆ **Stereoviewing capability**
- ◆ **High-image-quality products**
- ◆ **Continuity of service since 1986**

SPOT : Program

SPOT 1 :

- **launched 22 February 1986, reactivated 11 January 1997**
- **operating without onboard recorders**

SPOT 2 :

- **launched 22 January 1990**
- **onboard recorders lost October 1993**

SPOT 3 :

- **launched 26 September 1993**
- **ceased operating 14 November 1996**



SPOT 4 :

- **launched 24 March 1998, operated by Spot Image since 26 May 1998**
- **Features:**
 - new bus, new short-wave infrared band, Vegetation instrument

SPOT 5 :

- **launched 4 May 2002**

SPOT : Satellite Evolution



Spot 1/2/3



Spot 4



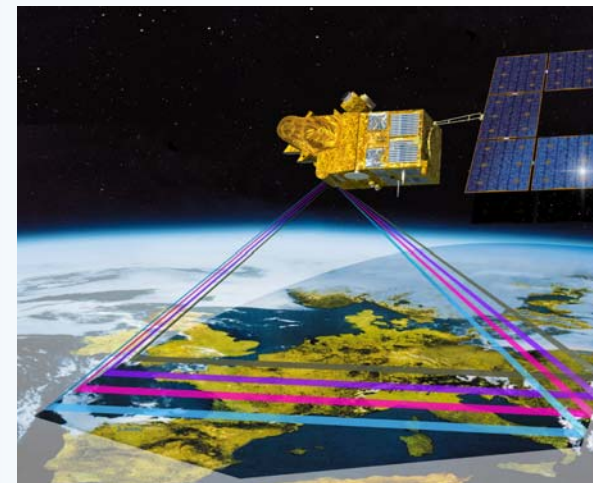
Spot 5

On-board pay-load			
On-board image processing	Two images can be processed at once, then sent directly or stored using a compression factor of 1.3	Two images can be processed at once, then sent directly or stored using a compression factor of 1.3	Up to five images Two sent in real or deferred time Three stored Compression factor: 2.6
On-board storage	Recorder: 2 x 60 Gbits 160 images	Recorder: 2 x 120 Gbits solid state memory: 9 Gbits (400 images)	solid state memory: 90 Gbits 550 images
Downlink	50 Mbits/s - 8.2 GHz	50 Mbits/s - 8.2 GHz	2 x 50 Mbits/s - 8.2 GHz
Modulation/coding	uncoded differential QPSK	uncoded differential QPSK	Differential QPSK + BCH(252,236)
Orbit determination	DORIS	Real-Time DORIS	Real-Time DORIS

VEGETATION data are used chiefly to:

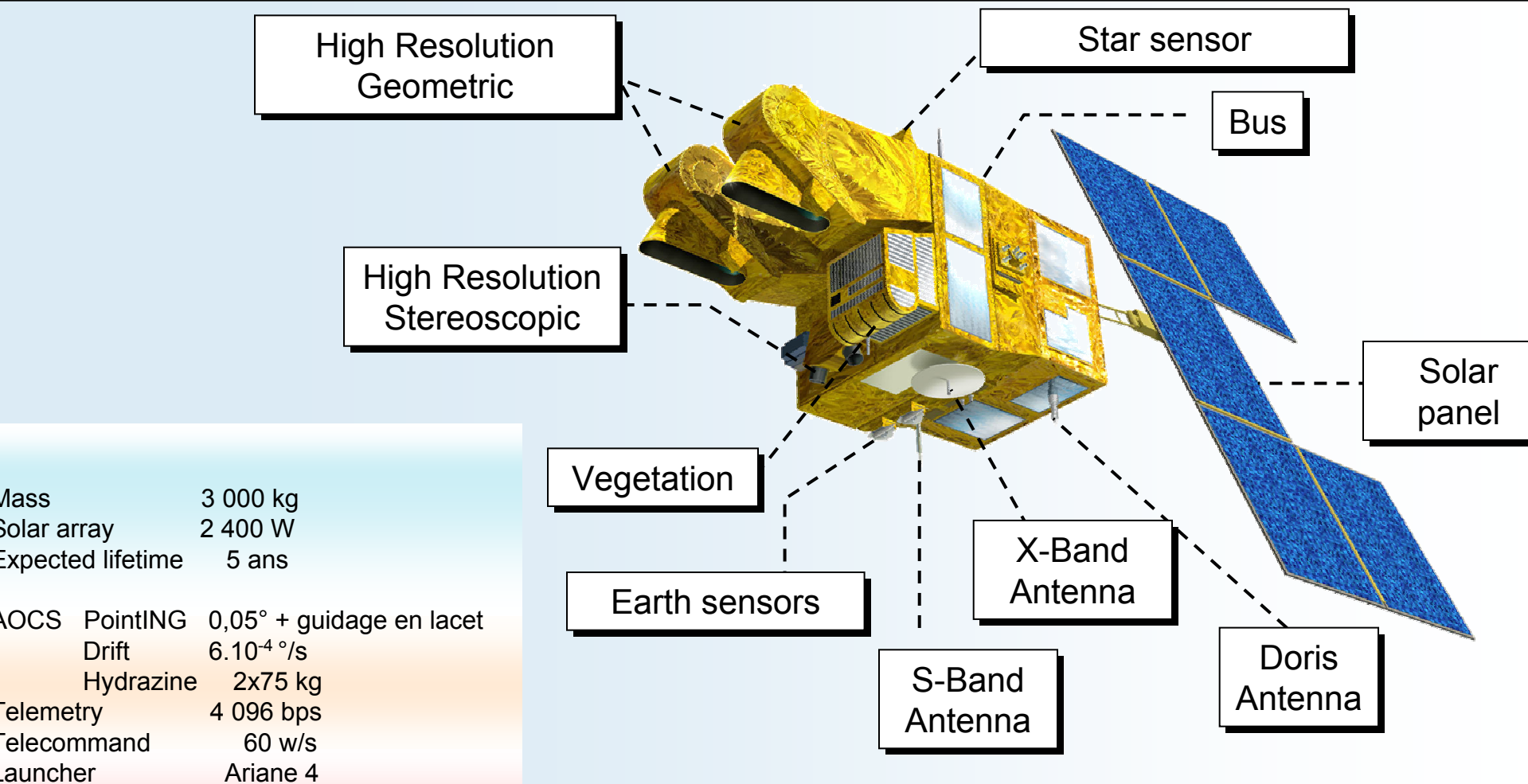
- **Map surface parameters**
- **Establish crop, rangeland and forest yields**
- **Monitor and model the mechanisms of the terrestrial biosphere**
- **Analyse environmental change**

The VEGETATION 2 instrument on SPOT 5 is pursuing the mission of the payload launched on SPOT 4 in 1998



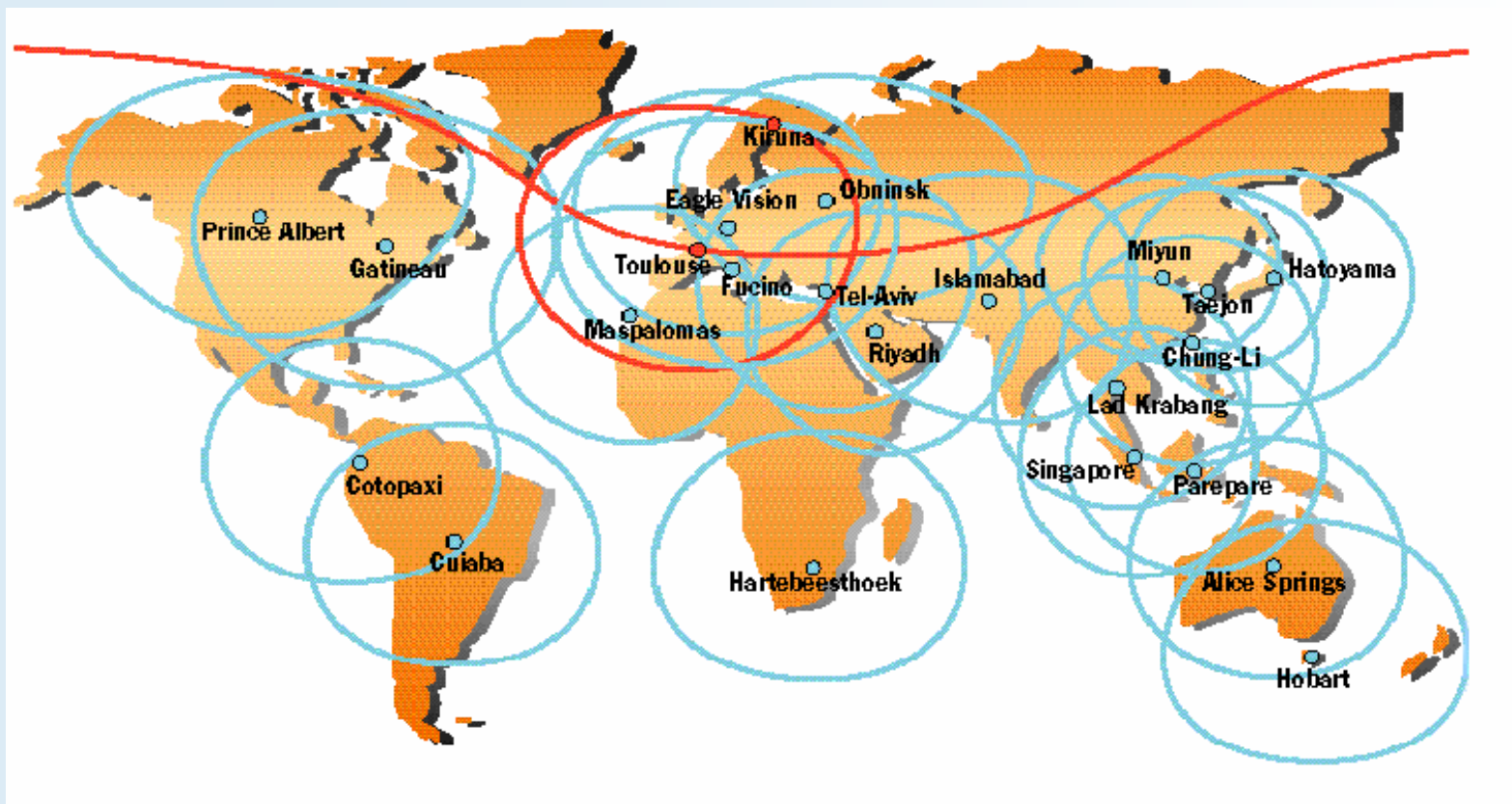
VEGETATION 2 mission transmits data at symbol rate of 3.4MBps in BPSK modulation (X-Band)

SPOT 5 Satellite



<http://spot5.cnes.fr/>

SPOT : Receiving stations network



• Main receiving station

• Direct receiving station

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Market driven applications



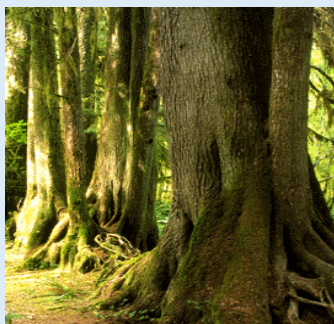
..... Agriculture

- Precision farming
- Crop yield forecasting and monitoring
- Crop yield statistics, soil diagnosis



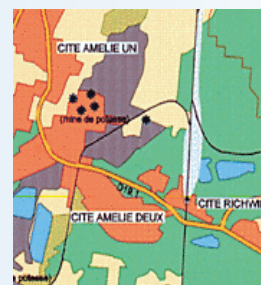
..... Defence and security

- Surveillance, intelligence
- Damage assessment
- Vulnerability assessment
- Target detection and location



..... Forestry

- Timber production
- Forest inventorying
- Deforestation
- Monitoring
- Forest degradation



..... Mapping

- Mapping and topography
- Land-use and infrastructure planning
- Coastal management
- Urban planning



..... Oceans

- Navigational aids
- Shipping traffic monitoring
- Sea ice and coastal monitoring



Hazard management

- Floods, forest fires
- Landslides
- Earthquakes
- Industrial hazards

⇒ Space Segment

- one-metre resolution (20-km swath)
- other overflight in the next 24 hours **requires two HR satellites**
- daily acquisition capacity of 250 images per satellite
- Mass: 900 kg

⇒ Power

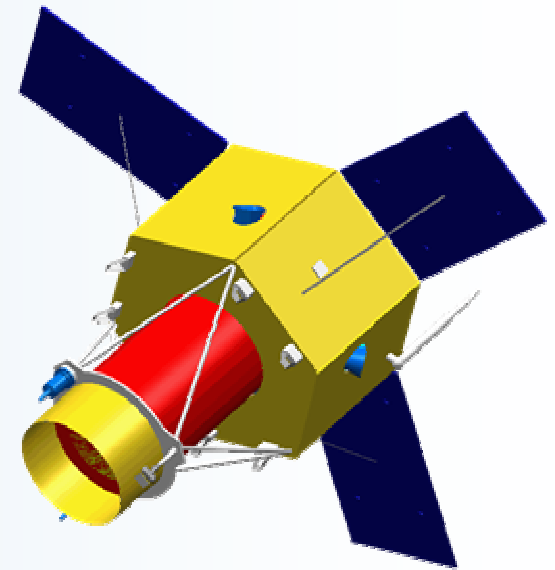
- Lithium-ion batteries
- Rigid gallium arsenide solar panels

⇒ Attitude and orbit control subsystem

- Gyro actuators
- Star sensors
- Fibre optic gyros

⇒ Image telemetry at 489 Mbps

- Three channels (163 Mbps)
- 4D 8PSK TCM 2.5bit/Hz/s with a RS(254,238) code
- Quasi iso-flux antenna
- 600-Gbit mass memory
- Wavelet compression (mean rate = 4)



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DEMETER (Detection of Electro-Magnetic Emissions Transmitted from Earthquake Regions) is the first project in the CNES Myriade micro-satellite series.

The scientific purpose of the mission is to :

- **study the ionospheric disturbances related to seismic activity,**
- **study the ionospheric disturbances related to human activity,**
- **study the pre- and post-seismic effects in the ionosphere,**
- **contribute to understand the mechanisms generating those disturbances,**
- **give global information on the Earth's electromagnetic environment at the satellite altitude.**

♦ Instruments :

- electric sensors,
- magnetic sensors,
- a plasma analyser,
- a Langmuir probe,
- a particle detector



♦ Downlink in X-Band :

- 4D 8PSK-TCM at 9MBauds with RS(254,238) coding
- Output spectrum shaped with a microwave filter (SFCG 21-2)

♦ Satellite

- Polar orbit at 800 km
- Lifetime 2 years

Low-cost micro satellite series Myriade

⇒ Increase of the scientific Earth Exploration missions

High resolution or large field optical and radar sensors

⇒ Increase of downlink data rates

⇒ Increase of the interference probability in X-Band

CNES Studies on 4D 8PSK TCM

⇒ Increase the spectral efficiency of transmissions in X-Band